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ABSTRACT

This document highlights key moments in the history of science chosen for their national impact and for the insight they provide on the values and principles that guide the inner workings of the National Science Board (NSB) in its governance of the National Science Foundation (NSF) and its role in national policy. This brochure takes a walk through the history of the board from the 1950s through the 1990s. Highlights include peace and the cold war, setting terms for academic science, strengthening White House science policy, the Mansfield amendment, K-12 and undergraduate education, and the frontier of information technology. Former members of the board and executive secretaries and officers are also listed. (SAH)

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ED 449 992

Eighty-first Congress of the United States of America

At the Second Session

Begun and held at the City of Washington on Tuesday, the third day of January, one thousand nine hundred and fifty

AN ACT

To promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes.

***Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That this Act may be cited as the "National Science Foundation Act of 1950".**

ESTABLISHMENT OF NATIONAL SCIENCE FOUNDATION

SEC. 2. There is hereby established in the executive branch of the Government an independent agency to be known as the National Science Foundation (hereinafter referred to as the "Foundation"). The Foundation shall consist of a National Science Board (hereinafter referred to as the "Board") and a Director.

Approved
May 10, 1950
Harry Truman

The National Science Board
A History in Highlights
1950-2000

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DR. MARTA CEHELSKY, Executive Officer

*NSB Nominee pending U.S. Senate confirmation.

The National Science Board consists of 24 members plus the Director of the National Science Foundation. Appointed by the President, the Board serves as the governing board of NSF and provides advice to the President and the Congress on matters of national science and engineering policy.

Eighty-first Congress of the United States of America

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PREFACE

The quest for new frontiers over the last half of the 20th century has increased our Nation's prosperity, created vast new areas of economic activity, and improved the quality of our lives. The systematic pursuit and exploitation of new knowledge, through small steps and transcendent leaps, has built a solid foundation for the future. Through its stewardship of the National Science Foundation and its advice to the President and Congress on science and engineering policy, the National Science Board has been a vital contributor to the astounding progress in science and technology we have witnessed during the past 50 years.

The Board was established by an Act of Congress in 1950 to serve as the independent governing board of the National Science Foundation. The framers of the 1950 Act insisted that the Foundation be run by those who understood science firsthand. The National Science Board consists of twenty-four men and women and the Director of the National Science Foundation—eminent scientists, engineers, and educators—who guide the work of the government's fundamental science and engineering research agency. This diverse, rotating cast of members from large and small academic institutions, various disciplines and regions of the country, foundations, and private industry provide their time and expertise to ensure that America's investment in the future remains strong.

On the occasion of the National Science Board's fiftieth anniversary, we celebrate an institution that has helped chart a course toward and through some of the world's most challenging advances in knowledge. This brochure, a "history in highlights," offers snapshots of key moments chosen for their national impact and for the insight they provide on the values and principles that guide the inner workings of the Board in its governance of the National Science Foundation and in its national policy role.

The relationship between the Board and the Foundation is distinct among government research agencies. Indeed, the Board's second Chair, Chester Barnard, president of the Rockefeller Foundation, used to refer to the Board as "this peculiar organization." The singular partnership between the Board and the Foundation has been largely responsible for creating in the United States what is the world's most vibrant and fruitful research environment.

If in the 20th century science and technology moved toward center stage, in the 21st century they will command it. Our quality of life will depend in large measure on our Nation's ability to generate new wealth, safeguard the health of our planet, and create opportunities for enlightenment and individual development. The contributions of research and education in science and engineering make possible advances in all these areas.

As we embark on a new century where research has become global and the need for cooperation and innovation has never been greater, we pause to remember the many distinguished men and women who have contributed so much to the Board's and Foundation's success and honor their work. We hope these highlights from the history of the National Science Board illuminate not just where science has been, but also the principles of excellence, independence, and public service that will enable us to meet the grand challenges ahead.

Eamon M. Kelly, Chair
National Science Board

Acknowledgements

Many colleagues brought this publication to life. I wish to thank, on behalf of the entire Board, the members of the NSB 50th Anniversary Task Force, including former members Sanford Greenberg and Eve Menger, who, in creative alliance with Low•Associates (L•A) and the NSB Office staff, produced this commemorative booklet. We are particularly grateful to researcher and principal author Deborah Shapley; to L•A project directors Terry Savage and Nan Russell, and their staff for the outstanding design and layout of the publication; and to the NSB Executive Officer Marta Cehelsky, Senior Policy Officer Daryl Chubin, and Task Force Executive Secretary Susan Fannoney. Their stewardship, keen eye, and attention to tone and detail were vital in executing the rigorous external review process sought by the Task Force. Such exemplary teamwork has sustained the National Science Board throughout its 50-year history.

Many associated with the Board, too numerous to mention individually, contributed to this document. Some participated in phone and in-person interviews conducted by Ms. Shapley. Others graciously submitted personal recollections, comments, and artifacts that were used in shaping the narrative of the booklet. Special thanks go to former NSB Chairs Herbert Carter, James J. Duderstadt, Mary Good, Norman Hackerman, Frank Rhodes, Roland Schmitt, and Richard Zare; former NSB members Charles Hess and Shirley Malcom; and former NSF Directors H. Guyford Stever and Erich Bloch. NSF Director Rita Colwell provided attentive review of the document as a participant-observer of the last 15 years of NSB history. In addition, long-time "consumers" of Board actions – J. Merton England, Patrick Windham, and Wil Lepkowski – provided important reactions to a draft of the text, as did NSF staff members William Blanpied, Mary Clutter, Patricia Garfinkel, and Curt Suplee.

While none of us has a definitive view of the past, together we have fashioned a document that captures both the public and behind-the-scenes interactions that endowed the National Science Board with a unique place in the history of U.S. science policy and practice. The NSB web site <www.nsf.gov/nsb> will proudly display the text and supporting documentation for the commemorative booklet.

Again, many thanks to all whose time and generosity made this effort so successful.

Vera C. Rubin
Chair, Task Force on NSB 50th Anniversary

Task Force on NSB 50th Anniversary

Vera Rubin, *Chair*

Jane Lubchenco

Richard Tapia

Warren M. Washington

Susan E. Fannoney, *Executive Secretary*

The 1950s

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1945-1959: PEACE AND COLD WAR

When World War II ended in September 1945, scientists in the United States were regarded with respect and awe for the seeming miracles—penicillin, radar, the just-revealed atomic bomb—that transformed civilization. Senior scientists and engineers who had managed wartime research called for a new agency to make federal patronage of research permanent. The Truman Administration agreed that the United States needed new knowledge to meet the mortal challenge of the new Cold War.

But the hoped-for single science agency never developed. By the time the National Science Foundation (NSF) came into being with the first National Science Board meeting in December 1950, the government had other important research sponsors, notably the Atomic Energy Commission (AEC) and the Office of Naval Research (ONR). In the 1950s, the Foundation grew cautiously in the shadow of larger research agencies; Board and Director sidestepped the national policy role assigned to them by law. By 1957, when the Sputnik crisis convinced Americans that the Soviets were winning the Cold War, the Foundation had gained enough stature to warrant a major expansion.

The Debate of 1945-1950

Vannevar Bush was a leading inventor and engineer. At the outset of World War II, he obtained the strong backing of President Franklin D. Roosevelt to harness the Nation's scientific resources. As head of the Office of Scientific Research and Development (OSRD), he organized hundreds of research projects in university and industrial laboratories. By war's end, Bush was one of the most famous scientists in the Nation. An April 3, 1944 cover story in *Time* magazine called him the "General of Physics." When peace came in the summer of 1945, the "general" was marshaling his troops on another front—the creation of a peacetime government agency that would replicate OSRD's success.

During the war, Bush had convinced Roosevelt that the most efficient way to use the Nation's best university researchers was to keep them on their campuses and fund them from Washington. Historically, American science was undertaken in private laboratories and self-supporting universities—in 1930 universities performed $20 million worth of privately funded research (equal to about $170 million in today's currency). But OSRD brought enormous federal support to the table. By 1943, it had awarded $90 million in university research grants.

In 1944, Roosevelt asked Bush to prepare a report on postwar arrangements for science. Bush convened four committees of leading figures, including James Conant, president of Harvard; Lee DuBridge, who ran the wartime Massachusetts Institute of Technology (MIT) lab that developed radar; Isaiah Bowman, president of

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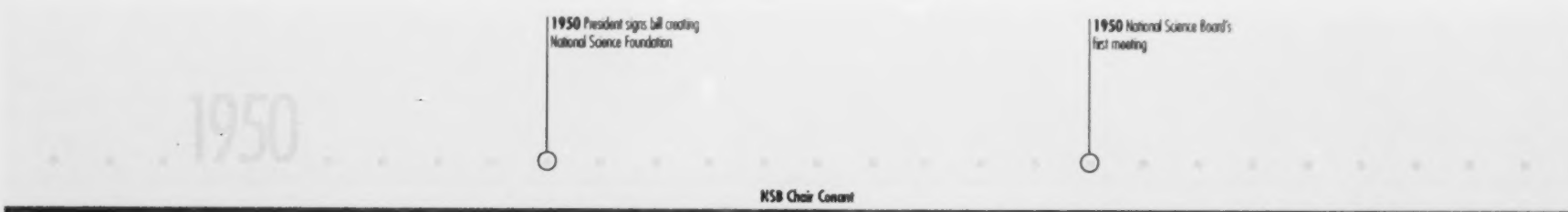
1950
1950 President signs bill creating National Science Foundation
1950 National Science Board's first meeting
NSB Chair Conant

Johns Hopkins University; Henry Allen Moe of the Guggenheim Memorial Foundation; and leaders from medical schools and private foundations. When the report was ready in May 1945, Roosevelt had died and the new president, Harry S. Truman, received it.

Science—The Endless Frontier was a manifesto for government to provide regular funding for university basic research and the education of future scientists through a single new agency. But the report stated strongly that to protect it from undue political influence, the novel enterprise had to be managed by scientists themselves. The report proposed a national research foundation run by a board of "nine Members, who should be persons not otherwise connected with the Government."

Truman thanked Bush and allowed *Science—The Endless Frontier* to be released without comment. Immediately, Bush arranged for Senator Warren Magnuson (D-WA) to introduce a bill that would implement the report. But in fact, the President did not agree with the plan. He wanted the central science agency to have a single Director answerable to him. As Harold D. Smith, director of the Bureau of the Budget (BOB), said in hearings, "An agency which is to control the spending of public funds in a great national program must be part of the regular machinery of government."

Bush and his colleagues, including Bowman, took issue with Truman. Claiming to represent the voice of American science, they gathered thousands of signatures and published their letter to Truman in the *New York Times*. The group argued that if control was in the hands of a single, politically appointed Director, he would be unable to win over the best universities, nor guide them wisely. When a bill to create a Board-controlled Foundation passed Congress in 1947, Truman vetoed it.

The fight over competing visions of who should control the new agency dragged on. Another issue was the Foundation's national policy role. The Truman White House and Bureau of the Budget wanted the Foundation to evaluate other agency research programs and make national science policy. A report by Truman aide John Steelman in 1947, which surveyed research and development (R&D) across government, supported Truman's case. But the fast-growing AEC, ONR, and National Institutes of Health (NIH) arranged for their Congressional patrons to minimize the proposed new agency's role in prospective bills.

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The compromise bill that finally passed in 1950 stated that "the Foundation shall consist of a National Science Board…and a Director," both appointed by the President to six-year terms. Truman and BOB got a Director; Bush and his colleagues got a governing Board of twenty-four-members who "shall be eminent in the fields of the basic sciences"…and "selected solely on the basis of established records of distinguished service." The Board members, and not the President, would elect the Board's Chair.

1951 McClintock presents evidence of transposable genetic elements (Nobel 1983)

1951

NSB Chair Bernard
NSF Director Waterman

The Foundation was to evaluate and correlate federal research programs and "develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences." On May 10, 1950, at a train stop in Pocatello, Idaho, President Truman announced he had signed a new law, P.L. 81-507, that "established in the executive branch of government an independent agency to be known as the National Science Foundation."

Activating the Board and Foundation

The Foundation was conceived, but not yet born. On June 25, 1950, North Korean forces attacked South Korea and troops mobilized under United Nations Commander General Douglas MacArthur were ordered to push them back. Truman declared the North Korean aggression a Communist strategy to undermine "the free world." In the press of emergency appropriations, the House hacked to zero the $450,000 the Administration had requested for the new science agency. DuBridge wrote to Steelman: "Would the possibility of reinstatement [be] increased if the President should promptly announce the creation of the National Science Board and the activation of this important new agency?"

Promptly following DuBridge's letter, the National Academy of Sciences, as allowed by the NSF Act, gave the White House a list of those it thought qualified for the Board. On September 30, 1950, Truman signed letters of invitation to some of the men on the NAS list, but also to others suggested by Steelman, among them two women, two African American academics, and two members of the Catholic clergy. Later, Congress decided on a budget of $225,000 for the Foundation through June 1951.

A Political Director?

It was an imposing group that gathered at the White House on December 12, 1950. Though President Truman had not yet arrived, Steelman opened the meeting. Board members elected Conant as chairman and Charles Dollard of Carnegie Corporation of New York as vice chairman. The NSF Act mandated an executive committee, of which Detlev W. Bronk was elected chairman. Bronk, a biologist, was president of Johns Hopkins University and of the National Academy of Sciences.

Members at this first meeting had heard rumors that Truman had offered the post of the Foundation's Director to someone they considered less than qualified for the job: Frank P. Graham, a lame-duck U.S. Senator and former history professor. According to later accounts, Truman showed up and asked what they had been talking about. Someone replied that they'd been wondering what qualifications Truman thought were appropriate for the Foundation's Director.

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1952 Eisenhower elected President

1952 U.S. explodes first hydrogen bomb

1952 Miller simulates origin of life from inert chemicals

1952

NSB Chair Bernard

NSF Director Waterman

"Financial support for research serves a double purpose: Acquisition of scientific knowledge and development of scientists."

Chester I. Barnard, Board Chair (1951-1955)

Truman answered, "There's only one criterion. He must get along with me." Thus continued the tension of how much the White House would control a Foundation explicitly endowed by Congress with its own independent governing Board.

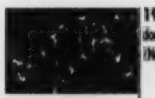
By law, the President was required to seek the Board's advice before making a formal nomination. Board protests eventually caused Graham to withdraw from consideration. At the Board's fourth meeting in March 1951, a telegram from Truman announced he would nominate Alan T. Waterman, former Yale physicist and chief scientist of the ONR, as Director. Waterman had been on the Board's list of candidates for Director, and his nomination was greeted "with audible relief" by the members.

A Science Advisor for the President, a Defense Role for NSF?

Just as contentious as the matter of who should serve as the Foundation's Director was the question of whether there was a need for a White House science advisor. Early in the Board's tenure, Wall Street banker William T. Golden became President Truman's consultant on the question of how to mount another major research effort if the Korean hostilities accelerated into a third world war. In late 1950 and early 1951, Golden discussed with scientific leaders in and out of government, including the Board, the idea that the President should have a science advisor.

At its second meeting on January 3, 1951, the Board opposed Golden's notion of a science advisor because that job would entail national policy advice as well as the coordination of government research, including defense research—responsibilities the NSF Act had granted to the Foundation. Ironically, Board Chair Conant did not think the tiny Foundation should activate its defense role, but "things just snowballed" at the meeting because Executive Committee Chairman Bronk, whom Board members overwhelmingly supported for the Director's job, said he would not consider the position if the Foundation did not exercise its full powers. Thus, in order to keep Bronk a candidate for Director, the Board went on record opposing the science advisor plan.

Soon afterwards, Bronk met with the trustees of Johns Hopkins, who doubted he could be president of NAS, director of the new Foundation, and president of their university all at once. Bronk took himself out of the running for Director. The science advisor question would arise again later, but for the moment the Board, at its third meeting in February 1951, took the opportunity to issue a statement that the Foundation would not, after all, activate its defense role.



1953 Watson and Crick determine double helical structure of DNA (Nobel 1962)

1953

NSB Chair Barnard

NSF Director Waterman

Setting the Terms for Academic Science

The early Board set up committees corresponding to the eventual divisions of the yet-to-be staffed Foundation. The Board tried to organize graduate fellowships for scientific study or scientific work, but the initial year's budget was too small. The first fellowships were not awarded until 1952.

When Waterman became Director, he decided the Foundation would operate as had ONR by awarding grants instead of contracts. Grants gave investigators more freedom and were less cumbersome to administer. They also implied trust and lessened the impression of government control. In addition, Waterman decided that staff would use outside panels to advise NSF about which proposals to fund.

Following a format used by the Rockefeller Foundation, Waterman and the staff presented the Board with a slate of grants to award—all in biology, as it happened—on February 1, 1952. Board member James A. Reyniers wrote a letter to Bronk, saying that "some Board members were not at all pleased by the 'rubber stamp' manner in which the 'docket' of grants was presented to it for approval." He went on to complain that the incident was indicative of NSB's "growing isolation from the operation of the agency."

Board members went into executive session and afterwards, their qualms allayed, approved the slate. Communications between Waterman and the Board remained cordial and productive through this and other twists along the path to a fully functioning Foundation. Waterman made a concerted effort to engage the Board at a level of decision making that would still allow him to manage Foundation affairs from day to day. But it was clear that a key decision point had been passed: the Foundation would be largely staff-run.

Historian J. Merton England notes how much the choice of Waterman as the Foundation's first Director shaped the agency—right down to the multiple-choice rating system for the scientific quality of proposals (from "excellent" to "poor") that remained in use for decades. Besides influencing the procedures and values of Foundation staff, Waterman left another legacy: close and considerate working relations between the Director and the Board.

Defending Political Freedoms

The White House and BOB, as during the debate of 1945-1950, wanted the Foundation to exercise a national policy role. However, both Waterman and the Board worked to avoid becoming a central coordinator and evaluator of federal R&D programs. Compared to other federal agencies such as the AEC and NIH, the Foundation's resources were miniscule. Taking possibly controversial stands on other agencies' programs could make NSF vulnerable to retaliation.

Martha J. Powell/University of Alabama

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1954

1954 Supreme Court in Brown v. Board of Education declares segregated schools illegal

1954 First human organ transplant

1954 Salk develops (introduces) vaccine against polio

NSB Chair Bernard

NSF Director Waterman

10

The 1960s

PHOTO KSF Collection

GROWTH AND CONFIDENCE

In his January 20, 1961 inaugural address, John F. Kennedy declared that "the torch has been passed to a new generation, born in this century, tempered by war and disciplined by a hard and bitter peace." He launched a rapid U.S. missile build-up and established the Apollo program to best the Soviet Union in the new frontier of space. The Cold War turned icy with showdowns over Berlin in 1961 and Soviet missiles in Cuba in 1962. Scientific research was part of the Nation's Cold War arsenal, though Kennedy praised its intellectual value as well. Federal support for research and development stood at $8 billion in 1960 and would double in five years. Within that total, support of basic research at all federal agencies more than tripled. By 1965, NSF's budget reached $416 million, with almost $276 million supporting research and the rest funding education, including graduate education.

There followed enormous growth in large-scale scientific projects and advances across all disciplines, thanks to generous support from an array of federal agencies. As the decade advanced, the Nation's environmental awareness grew, as did hope that the social sciences would address poverty and crime. During Lyndon B. Johnson's presidency, higher education gained federal support, though university-government relations became strained over the Vietnam War.

Strengthening White House Science

The frightening uncertainties of the Cold War triggered a spurt of new federal R&D programs and the need to coordinate them. Right after *Sputnik*, President Eisenhower appointed a Special Assistant for Science and Technology (later called the Science Advisor), the President's Science Advisory Committee (PSAC), and created an interagency Federal Coordinating Council for Science and Technology.

Seeking even greater central coordination, in 1961 Senator Henry Jackson (D-WA) recommended that Congress create an Office of Science and Technology in the White House. "The undischarged planning and evaluation responsibilities of the NSF," he wrote, should be transferred to the new office.

The Board responded by appointing a committee under William O. Baker of Bell Laboratories. Baker had advised a series of Presidents on classified defense matters; he saw the Kennedy team regularly, and so knew its thinking. Baker's report essentially agreed with Jackson's assessment, arguing only that the proposed Office of Science and Technology (OST) should be placed in the White House under the Special Assistant. OST's job should be to review, coordinate, assess and evaluate the state and conduct of federal science and technology. A small staff of "skillful reviewers" would consider a portion of the national total in any given year, working in small panels and drawing on PSAC's expertise.

"In today's world, the tide of political power flows with the tide of scientific and technical power."

Senator Henry Jackson (D-WA), Report, Subcommittee on Government Organization, 1961

1960
1960 Kennedy elected President
1960 Integrated circuit devised, the term "silicon chip" first used
NSB Chair Bronk
NSF Director Waterman

A Matter of Loyalty

The budding antiwar movement reached the Board in the summer of 1966, when Stephen Smale, a Fields Medal-winning mathematician, criticized the United States' Vietnam policy. Some in Congress called for revoking his NSF grant and wanted "no further grants made to individuals whose public statements and actions are clearly intended to give aid and comfort to the enemy."

The Board supported NSF Director Haworth's response, in which he cited NSF's 1956 loyalty policy. Smale had spoken out but not been convicted of any disloyal act. Haworth told Congress the "facts known to the Foundation provide no basis for termination of support to...Professor Smale."

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Kennedy's aides wanted to make the Foundation more responsive to White House control. BOB officials and newly appointed Special Assistant for Science and Technology, Jerome B. Wiesner, wanted to reduce the Board from twenty-four to twelve members, and to have the Director serve also as Chairman of the Board. In their view, the Board should become an advisory body only and leave the Foundation's management solely to the Director.

Wiesner and two budget officials met with the Board in closed session on March 15, 1962. Board members objected to requiring the Director to serve as Chairman, arguing it was a conflict. Stratton proposed making the Director the Chair of the Executive Committee instead, a compromise that was later accepted. The Board insisted that it needed twenty-four members to represent all regions and institutional types. The question of making the Board merely an advisory group was dropped.

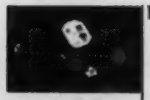
In late March, President Kennedy issued Reorganization Plan No. 2, which created an OST with policymaking and coordinating powers. The Foundation's official authority remained unchanged.

Golden Age of Growth

In the decade following *Sputnik*, the Foundation's budget grew tenfold, from $40 million in FY1957 to $465 million in FY1967. The Foundation used the funds in strategic ways that resulted in many of the most exciting scientific and technical achievements of the modern era.

A proposed major expansion of the Foundation's focus came before the Board in 1961. Foundation staff members, in touch with university and college administrators around the Nation, had heard that while they were grateful to get some overhead from each investigator's individual grant (usually 15 percent in the early years, though much higher later on), the totals in any one year were unpredictable. These administrators wanted to improve their facilities and programs systematically without having to depend on fluctuating levels of overhead. NSF staff proposed the creation of "institutional grants," which the schools could spend flexibly. The Board liked the idea and asked the Foundation to implement the new grants as soon as possible.

But there was another, related issue to address. Institutions won NSF research awards based on scientific merit, creating what Board Chair Eric Walker called "a kind of spiraling situation" in which the best institutions got better. As Walker told Congress in 1965, colleges in "New England and on the West Coast...get a higher percentage of the grants...pay higher salaries, attract better people, and continue to submit the best proposals.... It is very difficult, and I think quite undesirable, to fight excellence. It is hard to weed out the fault without eradicating the virtue."



1960 First weather satellite

1960 Jacob and Monod discover genes are turned on/off by other segments of DNA (Nobel 1965)

1961 Antarctic Treaty signed to continue scientific cooperation in region begun in IGY

1961

NSB Chair Bronk

NSF Director Waterman

As a remedy, the Director proposed the creation of University Science Development Grants, designed for the second twenty or so schools that aspired to be "centers of excellence." The Board approved the program in June 1962, but deferred it when additional appropriations did not materialize. Through 1972, NSF would invest more than $180 million in the program, which greatly expanded the capabilities in research and science education of many U.S. institutions. NSF's commitment to institutional grants over time fostered excellence nationwide, allowing many research universities to gain worldwide preeminence.

Growth also meant an expansion of large-scale science. NSF's Antarctic program was flourishing, and by FY1967, in addition to the Green Bank and Kitt Peak observatories, the Foundation had five stellar telescopes operating and a sixth under construction. The Foundation also launched Kitt Peak's counterpart in the Southern Hemisphere, Cerro Tololo Inter-American Observatory in Chile. In November 1965, NSF became the government's lead agency for ground-based astronomy.

Other large-scale projects sprang up. The National Center for Atmospheric Research housed the High Altitude Observatory to study sun-related phenomena. Ship-based ocean-drilling studies around the world suggested that sea floor spreading caused continental drift, an achievement that sparked strong, ongoing support for activities in geophysics and oceanography. New marine biology field stations started operations—NSF-supported scientists studied the Great Barrier Reef ecosystem and counted species in and along the Amazon River. The Board approved "Big Biology" in the form of the International Biological Program, which ran from 1968 to 1974. A less successful effort was "the great project Mohole," which the Board took up in Executive Committee. The plan to drill a hole through the sea floor to the juncture with the mantle, or "Mohorovic discontinuity," was so problematic that by the time Congress cancelled the program in 1967, critics had dubbed it "project no hole."

More than an Advisory Board

As the Foundation's activities became ever more robust, Board members wrestled with the ongoing question of how involved they should be in managing the agency's affairs. The Board had fought off the Kennedy Administration's efforts to reduce the Board's influence, but members themselves admitted from time to time that the Board "should stop worrying about details and possibly 'stepping on toes'...," as was recorded in the minutes of one long self-examination session in November 1965. Members at that meeting decried "the custom of determining what matters should be brought before the Board primarily on a dollar basis rather than on a policymaking basis." Instead of micromanaging operational details, the Board should be "more sensitive" to "what science can do for the public."

NSF Flies High

World War II's unprecedented air campaigns heightened interest in meteorology. Responding to a National Academy of Sciences recommendation, in 1960 the National Center for Atmospheric Research (NCAR) was organized in Boulder, Colorado, under the auspices of NSF. Its mission is to conduct research on a larger scale than what any single university could accomplish. A few years after the center's founding, the Board approved plans to build on Table Mountain a new state-of-the-art NCAR facility—Mesa Laboratory, one of architect I. M. Pei's first U.S. buildings.

1961 First electronic watch marketed

1963 Kennedy assassinated; Johnson becomes President.

1963 Quasars discovered

1964 Great Society/Civil Rights Act passed

1963

1964

NSB Chair Bronk

NSF Director Waterman

NSF Director Haworth

NSB Chair Walker

Pontiac

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On the other hand, members at the meeting strongly reconfirmed that the Board should serve more than a purely advisory function. The Board, they said, was "an excellent platform from which to act" and had "stood up to the Government for the scientific community in previous crises." The Director was "in an anomalous position, being responsible to the President, Congress and the Board," and could best be helped by the Board's giving him a "basis for objecting to action by other parts of the Government," or even acting as "a 'burr' to the Government, if necessary."

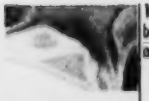
The Board enhanced the Foundation's effectiveness in other ways, members noted. Because "the Board has a rotating membership, the academic community feels close to the Board," and hence to the Foundation itself. What's more, "instead of the staff being limited to discussing ideas and plans among themselves," Foundation staff members benefit by "having to present recommendations to a Board with policymaking power… The very act of having to prepare presentations to the Board is apt to provide an objective viewpoint, which makes the staff carefully consider the wider view."

As it celebrated its 15th anniversary in 1965, the Board believed it was fulfilling the vision of self-governance by a pluralistic, merit-driven enterprise that Vannevar Bush outlined in *Science—The Endless Frontier* twenty years before.

Expansion into Engineering and Applied Research

From late 1964 through early 1968, the Foundation's authorizing committees in the House and Senate considered the Foundation's future role. The leader of the inquiry was Congressman Emilio Daddario (D-CT), chairman of the Subcommittee on Science, Research and Development of the House Committee on Science and Astronautics. Daddario held extended hearings in 1965 with an eye to extending the Foundation's mandate to include engineering, social sciences, and applied research. Because the Director and the Board embraced Daddario's aims—albeit cautiously—they were listened to in crafting amendments to the original 1950 Act. The amendments became law in July 1968 as P.L. 90-407. The situation unfolded much as in the mid-1950s: Congress perceived the Foundation as successfully managing its growth and rewarded it with broader responsibilities.

Daddario was a friend of the Foundation. He believed in the federal patronage of basic research and the coupling of research with education. The *zeitgeist* was shared by his Senate counterpart, Edward M. Kennedy (D-MA), who held similar hearings as chairman of the Special Subcommittee on Science of the Senate Committee on Labor and Public Welfare. In 1965, NASA's astronauts were national heroes, computers were rare items of public wonder, and physicists enjoyed particular prestige. Conventional wisdom held that if other fields adopted the methods of physical science, they could solve the Nation's problems.



1965 Discovery of microwave background by Penzias and Wilson

1965 1966 1967

1967 Regulation of genes through "chemical recognition"

NSB Chair Walker

NSB Chair Handler

NSF Director Haworth

The National Science Board benefited at this moment by having a plainspoken engineer as chairman, Eric A. Walker, president of Pennsylvania State University. Walker advocated an explicit role for engineering at NSF even as it maintained its mission in science.

Five Board members testified and two more gave written answers during Daddario's 1965 hearings. Bryn Mawr College President Katharine E. McBride praised NSF's awards to small colleges. Father Theodore M. Hesburgh, president of the University of Notre Dame, agreed the Foundation could diversify funding beyond the coasts: Midwest institutions produced thirty-two percent of the Nation's students in science and engineering, but received less than that percentage of federal research funds. Hesburgh eloquently argued for upgrading the social sciences at NSF, a position he had steadfastly held over eleven years on the Board. Harvey Brooks, Dean of Engineering and Applied Science at Harvard University, urged that NSF expand from thirteen percent of all federal academic research to closer to thirty percent.

The Board and Director worked closely with Daddario and Kennedy through 1966 and 1967 on the wording of amendments to the Act. Their insistence that the change not dilute NSF's core mission won the day. The final House report said applied research "should not... obscure and overcome the important work in basic research" at the agency. The amendments gave NSF explicit authority to support the social sciences and engineering, as well as a clearer role in international scientific cooperation, computer technology, and data collection on the federal scientific effort.

Finally, the amendments clarified the roles of Board and Director—giving the Director more flexible authority in relation to the Board to help him run a bigger operation. The Board was empowered to issue an annual report, a new forum through which to speak on the health of science and engineering.

A Champion for Social Science

In 1958, Reverend Theodore M. Hesburgh, an early, influential member of the Board, was named head of a committee tasked with defining the Foundation's commitment to social science. Most decisionmakers then at the Foundation were from the physical sciences. During one meeting from which Hesburgh was absent, his committee—"in a stormy session," according to accounts—watered down the draft report and tried to bring it to a vote, a move resisted by Board Chair Detlev W. Bronk. Upon Hesburgh's return, he insisted that the Board vote on the original language. Writes historian J. Merton England, "perhaps this time the members were in a good mood, or perhaps they hesitated to challenge his obvious conviction." In any event, they approved the initial report.

1967 Pulsars discovered by Bell-Brunnell, graduate sudent of Hewish (Nobel 1974)

1968 Nixon elected President

1969 Meteorites found in Antarctica; first practical way to sample them

1969 Neil Armstrong first man on the moon

1968 1969

NSB Chair Handler

NSF Director Haworth

NSF Director McElroy

10

The 1970s

TURBULENCE AND TRANSITION

As American involvement in the Vietnam War continued, conflict over the war dominated national life. Soon after President Richard M. Nixon was re-elected in 1972, the Watergate scandal further divided the Nation and eroded the public's confidence in government. The Administration sought to deploy an antiballistic missile (ABM) system and to develop a supersonic transport (SST) aircraft, projects that ran into scientists' technical criticisms. The public also was disillusioned with technology projects that seemed too far removed from the riots, poverty, racial injustice, and pollution that were blighting America's promise. As a result, many in Washington and around the country pressured NSF to undertake work perceived to be more relevant to national needs. The Foundation did attempt new programs during these tense times, though real growth in NSF's budget would not resume until FY1983.

The Mansfield Amendment

In FY1968, NSF's budget grew to $505 million but inflation was such that, in constant dollars, the amount awarded was less than the year before. The next year was no better. Late in 1969, an amendment to the Military Authorization Act, introduced by Senator Mike Mansfield (D-WA), confused and alarmed both the defense and civilian research enterprises. The amendment barred the Defense Department from using its funds "to carry out any research project or study unless such project or study has a direct and apparent relationship to a specific military function." The impact on the Foundation was potentially enormous, since Mansfield estimated that certain research projects, which amounted to $311 million, could be dropped or picked up by other agencies, mainly by NSF.

Board member Norman C. Hackerman, chemist and president of Rice University, recalls that the Board debated objecting to "the intrinsic philosophy" of the Mansfield amendment, but decided instead to simply restate its long-held view that many federal agencies should support basic research, not just one. In the end, the Foundation took over sponsorship of some major materials research laboratories, but did not otherwise expand.

Growth Stops and the Board Protests

In 1966, the Board Chair was biologist Philip Handler, who also became president of the National Academy of Sciences in 1969. Handler protested the slowdown in funding for research and graduate education, but President Nixon seemed deaf to his concerns. In 1968, a Board Commission on the Social Sciences proposed twenty-five social science institutes at a cost of $10 million a year, but these were not funded. The Board's second annual report, which advocated expansion in physical sciences, got an icy note from the director of BOB stating that it failed "to acknowledge the broad range of pressures on the Federal Government for funding and the increasing problem of choices among national programs." On January 22, 1970, the Board sent the President a letter

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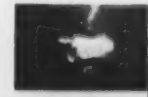
1970 First Earth Day; Clean Air Act passed; Environmental Protection Agency established

1970 Scanning electron microscope invented

1970 Temin and Baltimore discover reverse transcriptase (Nobel 1975)



1971 First year of International Decade of Ocean Exploration

1970 1971

NSB Chair Carter

NSF Director McElroy

"Having so much opportunity to interact with twenty-four people of such varied experience is a boon to any Director."

H. Guyford Stever, NSF Director (1972-1976)

proposing a new super agency for support of graduate and postgraduate education across the full range of fields. This idea, too, was stillborn.

Then the budget office (which in July 1970 became the Office of Management and Budget, or OMB) made clear it would not allow funds for new graduate traineeships. The economy was in recession, especially in the aerospace sector; scientists and engineers suffered unemployment in record numbers. On March 27, 1970, Handler sent a plea for reinstatement of the graduate traineeships, even though the President had just given an address on higher education that did not mention them.

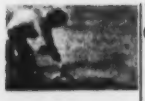
When they met with President Nixon on May 22, 1970, Board members hoped to discuss the "instability of Federal institutions as a result of present Federal funding procedures" and other issues close to their hearts. But the correspondence suggests that Nixon did not address this or any other prominent science-related issue.

A "Political" Director?

NSF Director Leland Haworth's term was due to end in May 1969. Seeking a successor, Nixon's Science Advisor (and former Board member) Lee A. DuBridge, asked chemist Franklin A. Long of Cornell University if he would come to Washington to meet the President about becoming NSF Director. But another Nixon aide told Long before the meeting that the President would nominate Long only if he publicly supported the ABM system. Long took offense and stormed back to Cornell.

In an unprecedented open letter, the Board protested this political litmus test. According to historian Milton Lomask, Nixon met with DuBridge and Handler and "confessed he had been wrong in his handling of the Long appointment." He agreed the Director's job should be nonpolitical. The Board's Executive Committee went to work sounding out other candidates.

Handler's feelings were evident in what he told biophysicist William D. McElroy of Johns Hopkins University, when he telephoned McElroy to ask if he would consider the job. Handler said, "the Science Foundation was going to hell, support of science was going to hell, and they had to have somebody at NSF who could do the job." However, as time would tell, the Board's involvement in the selection of a new Director was not a guarantee of good relations.



1972 Harmful effects of acid rain documented

1972 Invention of laser discs

1972

NSB Chair Carter

NSF Director Stever

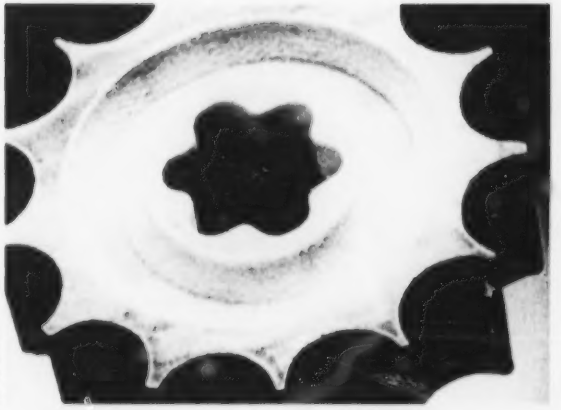
Competing Priorities

McElroy had been one of NSF's early stars, supported for work on bioluminescence in the 1950s. Upon becoming Director in 1969, McElroy broke with the Waterman-Haworth tradition in which NSF Directors sailed close to the preferences of academic science. From his visits on Capitol Hill, McElroy knew that the Foundation was expected to expand its applied research portfolio, as had been requested by the 1968 Daddario amendments. The winds of change were not lost on the Board. In March 1970, after careful study, the Board agreed to establish Interdisciplinary Research Relating to the Problems of Society (IRRPOS). The next year, when the Foundation asked for $13 million for IRRPOS, Congress showered it with $34.2 million.

Then on December 13, 1970, when Foundation officials were engaged in the yearly budget struggle, OMB told McElroy the President would ask for a multimillion dollar increase for FY1972 if the Foundation mounted an aggressive program to harness science to national needs. McElroy put the general idea to the Board on December 17; the Board "approved the Director's general organizational and program plans for expanding support in applied areas." Only after that meeting did McElroy tell the Board Chair the specific amount he had discussed with OMB: $81 million in a total proposed FY1972 budget of $622 million. Such a large applied program raised fears around the Foundation that the agency would be pulled away from its core mission in the basic sciences.

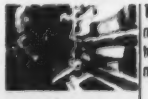
Sensing the unease but eager to gain the funding, McElroy appointed a task force that in some secrecy finished a plan on December 28 for a program entitled Research Applied to National Needs (RANN), encompassing applied projects meant to be of more immediate use to industry and the public. Board Chair Herbert E. Carter, a chemistry professor from the University of Illinois, personally approved the idea and the name on January 2, 1971.

Never warmly welcomed into the Foundation's scientist-dominated culture, RANN lurched forward until 1977, when it was discontinued at the recommendation of a special Board committee. Though it was supported by some colleges and universities whose students and administrators wanted more socially relevant research, RANN was constantly scrutinized by those who feared popular programs of applied research would reduce funding for basic research and graduate education. Historian Dian O. Belanger writes, "there was always at least a minority on the Board unhappy with RANN." In her view, "McElroy's failure to bring the NSB into the earliest policy- and program-forming process had to bear part of the blame.... [C]hange had been imposed, not negotiated, or even discussed."



NSF Collection

1973 Oil-exporting nations of OPEC raise prices, set off energy crisis

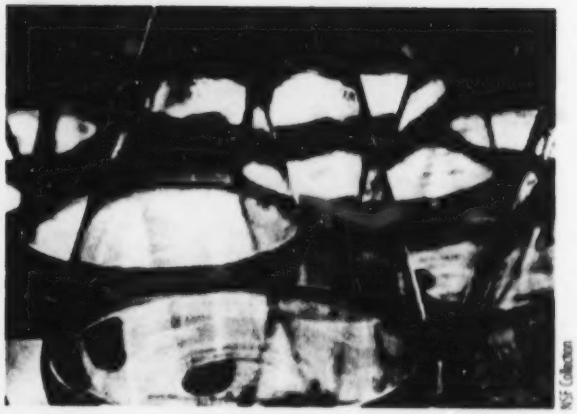


1973 Mathematics of solid modeling, eventually leads to CAD/CAM design in manufacturing

1973

NSB Chair Carter

NSF Director Stever



NSF Collection

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The Board's Bestseller

In 1972, the Board welcomed as NSF Director physicist H. Guyford Stever, former president of Carnegie Mellon University. Board members had been debating possible topics for the fifth annual NSB report. Member Roger W. Heyns, a social psychologist and president of the American Council on Education, suggested that the Board regularly publish data on scientific manpower and funds. Stever recalls that the idea was adopted quickly, with Heyns tapped to head the project.

In hindsight, the need for a popular publication with regularly updated data series was obvious. Though the Foundation had gathered some data since the beginning, as required by the 1950 Act, the Board and others still did not have systematic information with which to bolster their arguments concerning funding and manpower needs. How many students were in the educational pipeline? How many graduates in science and engineering were jobless or underemployed? Statements such as Chairman Handler's 1970 letter to Congressman Joe L. Evins (D-TN) that "the total magnitude of this crisis is unknown, but the level of apprehension across the country is very high" did not enhance credibility.

Science Indicators 1972 was published in early 1973 to immediate acclaim. At its October meeting, the Board approved an every-other-year publication schedule. Renamed *Science and Engineering Indicators* in 1984, the series continues to be a widely used resource around the world. The irony is that the Board, which had resisted a prominent role for social sciences at NSF, acted on the suggestion of one of its few social scientist members and created one of its most valuable contributions to the Nation.

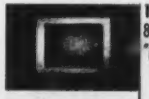
Supporting the Director as Science Advisor

In January 1973, simmering tensions between the Nixon White House and the university scientific community came to a boil. Press leaks showing that members of the PSAC were critical of the SST and ABM projects angered President Nixon; PSAC's abolition was imminent. Seeing the writing on the wall, the President's Science Advisor, Edward E. David Jr., formerly of Bell Laboratories, had resigned on January 2. Nixon also planned to dismantle the Office of Science and Technology.

In the midst of this turmoil, William O. Baker, a former Board member, suggested to Nixon that he could ask the Director of NSF to serve simultaneously as his science advisor, since the NSF Act gave the Foundation the job of advising on national policy and evaluating government research programs. When Treasury Secretary George P. Shultz, in his capacity as a special assistant to the President, asked Stever to become science advisor, Stever expressed interest, saying he wanted to consult with the Board.

1974 Crutzen, Rowland and Molina describe the formation and decomposition of atmospheric ozone (Nobel 1995)

1974 Nixon resigns, Ford becomes President



1975 The MITS Altair 8800 is hailed as the first "personal" computer

1974 1975

NSB Chair Hackerman

NSF Director Stever

Shultz told Stever not to tell the Board. Stever, nonetheless, arranged for Shultz himself to brief the Board at its next regular meeting, days away. Recognizing that the new arrangement was now perhaps the only way the President had of receiving science-related national policy advice, the Board voted to assist Stever in his new, second role.

The Board created a National Science Policy Subcommittee, which discussed publishing white papers or issuing policy statements on major subjects. The subcommittee hoped the Board could serve as an "early warning system" for the Science Advisor about upcoming issues of importance, and be available for "informal and confidential consultation." The subcommittee was succeeded by the Committee on National Science Policy, headed by geologist Frank Press of MIT. At the same time, the Board uncovered a number of never-released PSAC papers that had been written but not cleared by the White House. Stever and the Board released some of the PSAC papers on their own, such as "Chemicals and Health," one of the few authoritative warnings at the time that some synthetic chemicals could be harmful to humans.

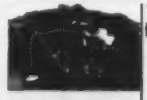
To assist Stever, in 1973 the Board helped to create two NSF offices—for science policy and for energy policy. The latter was very active when the oil embargo hit later that year, raising questions about the Nation's energy research priorities. Several RANN projects dealing with energy proved their worth at this time.

But Watergate was enmeshing the Nixon presidency. As it became clear that President Nixon might be impeached or resign, some in Congress and the science world met with Vice President Gerald R. Ford, the Michigan congressman appointed to the vice presidency in 1973. Ford agreed that the Foundation was not the right place for the science advisor. When Ford became President, Stever and the Board worked with his aides on legislation that succeeded in returning the science advisor to a stronger position within the White House. On October 1, 1976, Stever resigned as NSF Director to become Ford's full-time science advisor, signaling a thaw in relations between the White House and the science community.

At one point, Stever showed President Ford a chart from NSF's *Science Indicators* highlighting Japan and Europe's rising R&D compared to the sinking trend in the U.S. Stever believes that "from that point, he [Ford] began to think about" reversing the declining federal investment in research.

1976 ARPANet links defense computing sites; precursor to Internet

1976 Earthquake engineering research started by NSF using supercomputers



1976 "Lucy" hominoid fossil found

1976 Carter elected President

1976

NSB Chair Heckerman

NSF Acting Director Atkinson

43

MACOS Tests the Board's Oversight

Before Board members had a chance to enjoy the balmier climate, however, the MACOS controversy took them by storm. In March 1975, during what was to be a routine hearing before a subcommittee of the House Science and Technology Committee, Congressmen John B. Conlan (R-AZ) and Robert E. Bauman (R-MD) complained that some parents were protesting about a fifth- and sixth-grade anthropology course, developed with NSF funds, that conveyed what they saw as disturbing and un-American values. Foundation leaders at the hearing were caught off guard.

In *Man, A Course of Study* (MACOS), Harvard professor and education theorist Jerome Bruner and colleagues wanted to show different values in other cultures. Most of the material was inoffensive, but a few segments, including one that mentioned wife-sharing among Arctic tribes, proved shocking to some. NSF had supported the development of MACOS, along with dozens of other curriculum materials meant to boost learning in science and mathematics; the course was then being taught in thousands of schools.

The standard practice for proposals submitted to NSF was to subject them to peer review. Thousands of qualified researchers, painstakingly chosen by NSF, reviewed applications in a process that was designed to protect reviewers' identities and encourage candor. But after the House Committee hearing, NSF leaders discovered that negative comments by some reviewers of MACOS had been obscured by NSF staffers, who neglected to include the criticisms in the review summaries they sent forward.

In the aftermath, Board Chair Norman C. Hackerman warned his fellow members that "[T]hese recent events highlight the need for the Programs Committee to exercise its oversight role to a greater degree with respect to ongoing programs." At first blush, Congress appeared unwilling to wait, threatening to require that all 15,000 grant applications be screened on Capitol Hill prior to peer review at NSF. That idea died, but the Board conducted its own examination of the peer review system. Board members concluded that the system generally worked very well (a finding with which the National Academy of Sciences, in its own study, agreed). However, the Board ultimately voted to end the staff practice of crafting review summaries, recognizing their potential to mislead. Reviewers' comments would henceforth be forwarded to applicants verbatim.

Congress now gave the Board an explicit role overseeing peer review at NSF. Historian George Mazuzan writes that from the MACOS episode forward, the Foundation would be under "new pressure for accountability."

1977

NSB Chair Hackerman

NSF Director Atkinson

Steady State, Steady Strain

During its tenure in the late 1970s, the Carter Administration was well disposed toward NSF. President Jimmy Carter made former Board member Frank Press, a strong proponent of basic research, his science advisor. The White House and Congress increased current dollar funds for the agency, though rampant inflation took away any real gain.

Richard C. Atkinson, a Stanford University psychologist who had been Stever's Deputy Director, became NSF Acting Director in 1976 (he was confirmed as Director in May 1977, the first behavioral scientist to hold that position). Hackerman, the Board's chairman at the time, helped steer the Foundation among competing pressures. Some universities, for example, were calling for more applied programs within NSF. A number of Congressmen—with MACOS fresh in their minds—were pushing for greater public participation in NSF deliberations. In June 1977, the Board passed a resolution welcoming the appointment to the Board of "nonscience or public members." President Carter appointed more industry representatives to the Board so as to encourage more input from that important sector.

The Board also held hearings around the country, to learn what states and localities wanted from the Foundation. Hackerman favored new approaches to raising the quality of research and education in regions that normally did not succeed in the fierce competition for NSF funds. "The Foundation's awards are an educational tool, not just a scientific tool," he says today. "If you look at the roster of faculty of the top six or ten institutions, they come from everyplace.... So you have to cast the net broadly, to catch the neophyte who will be a good scientist or engineer."

In 1979, the Foundation launched the Experimental Program to Stimulate Competitive Research (EPSCoR). The program funds partnerships among colleges and universities, state governments, and industry in states that get the fewest NSF awards—eighteen states in the program's first year. During the program's initial decade, the Foundation's $43 million investment in EPSCoR attracted an additional $149 million worth of state spending.

The 1970s had been a rough-and-tumble ride, but with the Board's help, the Foundation emerged with a more socially relevant agenda, broader geographic distribution in funding, and the agency's commitment to basic science intact.

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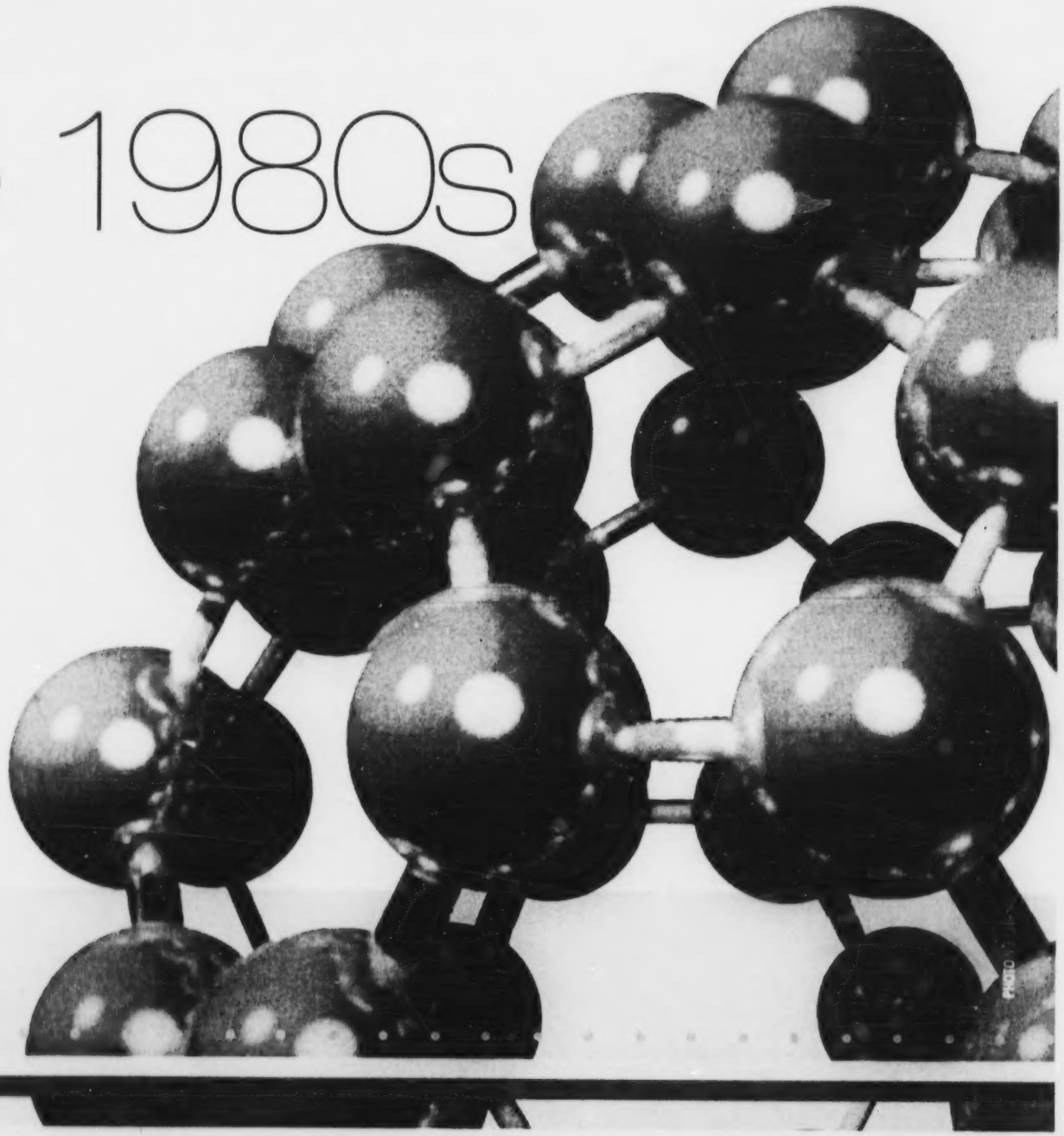
1979 First U.S. cases of AIDS reported by Centers for Disease Control and Prevention

1979

NSB Chair Hackerman
NSF Director Slaughter

24

The 1980s



RETHINKING AND REBUILDING

When Ronald W. Reagan was elected President in November 1980, Iranians held American hostages, oil-exporting Nations were raising prices, Japan seemed on track to become the world's economic powerhouse, and recession and high unemployment all rocked American confidence. Though hard to detect at the time, the stage was being set for a renewal of U.S. research. Companies began more university-based research partnerships, with biotechnology an early result. States invested more in local universities and colleges to attract high-tech industry and skilled workers. Whereas researchers on the East and West coasts had traditionally received most basic research funds, now researchers in many parts of the country competed for—and won—prestigious awards.

Though the Foundation reeled from budget cuts in the early Reagan years, the Administration's idea of rethinking government took hold. The Foundation evolved as a result of an innovative Director and strong Board leaders. By FY1990, when its budget had risen from $1 billion to $2 billion, NSF was a remodeled institution whose budget better served its core mission.

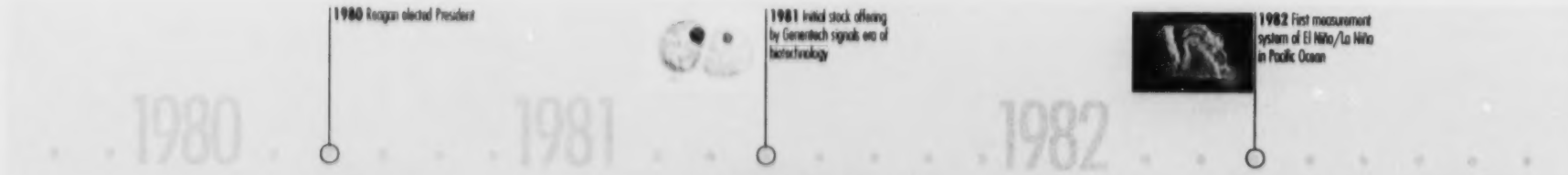
Engineering Gets a Promotion

By 1980, one of the Foundation's best friends in the House, Congressman George E. Brown (D-CA), chair of the Committee on Science and Technology, was criticizing NSF for not doing more to make U.S. technology more globally competitive. Brown (supported by engineers who, according to historian Belanger, felt "in the position of a neglected child"), pushed to set up a separate National Technology Foundation. The move forced NSF leaders to defend engineering's rather low status at the agency. NSF's long resistance to sponsoring engineering research stemmed from a belief that engineering was applied work, not basic scientific research. But a separate foundation did not seem desirable, either.

The Foundation's management was in flux at this time. The new Director–designate, electrical engineer John Slaughter, would not take office until December and the Acting Director was a university physicist, Donald N. Langenberg. The Board was in a better position to respond to Brown, given that it included more members than usual from industry. Board Chair Lewis M. Branscomb was a physicist and chief scientist at IBM. Vice Chair Herbert Doan worked at Dow Chemical. Another member, Joseph M. Pettit, president of Georgia Tech, chaired a Board group to study the oft-repeated charge that engineering research was, at best, "just" applied science.

"[D]edication, objectivity, and excellent research credentials on the part of each and every Board member are indispensable to the effectiveness of the Foundation. They constitute its protection from forces that, unopposed, would reduce NSF to just another federal agency."

Lewis Branscomb, Board Chair (1980-1984)


1980
1980 Reagan elected President
1981
1981 Initial stock offering by Genentech signals era of biotechnology
1982
1982 First measurement system of El Niño/La Niña in Pacific Ocean
NSF Director Slaughter
NSB Chair Branscomb
NSF Director Knapp

Drawing on the Pettit group, Branscomb argued that engineering research was neither basic scientific research nor applied science. Still, it was worthy of NSF support because when engineering research activities "stay ahead of state of the art they necessarily push up against the scientific frontier." University science and engineering had "an intimate relationship, each supporting each other." Therefore NSF, not some new foundation, should support basic engineering research.

The Board invited the National Academy of Engineering (NAE) to weigh in. The NAE endorsed a directorate in NSF rather than a new institution, and a new Engineering Directorate came into being in March 1981. To emphasize that it was now "not conceptually correct" to consider engineering an applied field, the Board determined that NSF's existing applied programs should be relocated to their respective disciplinary directorates rather than housed in engineering. The new directorate would foster innovations that helped to revive U.S. industry.

Peer Review Broadened

The advent of the Engineering Directorate prompted a rethinking of the Foundation's peer review process. Reviewers at the time used two main criteria: the intrinsic scientific merit of the proposal, and the qualifications and competence of the principal investigator. But now applied research projects were to be dispersed into other directorates, with the understanding that the distinction between "basic" and "applied" research should not be rigid. So in 1981, the Board oversaw a broadening of the criteria to include an additional two: the utility or relevance of the research, and the effect of the research on the infrastructure of science and engineering, including better public understanding and contributions to the Nation's education and workforce base. To signal the broader basis for judgment, the term "peer review" was changed in 1986 to "merit review" on Director Erich Bloch's recommendation. The Board also provided guidance on the emphasis to be given these criteria in various parts of the Foundation.

While other modifications have come under the Board's consideration since 1981, the spirit of these four criteria remains in effect today. In March 1997 the Board approved the restructuring of merit review to two mandatory criteria so that appropriate attention was given to integration of research and education and contributions to national goals.

K-12 and Undergraduate Education

In 1981, Foundation leaders learned that the Reagan Administration would cut all funding to the agency's education programs, except fellowships for advanced students. The social sciences were also curtailed in the raft of federal programs that had to shrink to accommodate Reagan's tax cuts and huge defense build-up. The Reagan

1984 *A Nation At Risk* sparks debate on K-12 education

1984

1984 Apple introduces the mouse and the pull-down menu

NSB Chair Schmitt
NSF Director Bloch

team singled out education, however, arguing it must be left to state and local governments. When the axe fell there was no appeal.

The Directorate of Education was abolished in April 1982. Later that year, Director Slaughter, the Foundation's first African American director, left the post; he had accepted the appointment from President Carter in hopes of a very different climate. Slaughter's successor was Edward A. Knapp, a physicist from Los Alamos National Laboratory, who had better ties to George A. Keyworth II, the President's Science Advisor.

Despite the chilly climate, the Board decided that it would initiate a national policy report on ways to improve the sorry state of U.S. science and mathematics education. Members took strength from a paper by Philip M. Smith, who had served previous NSF directors and in the President's Office of Science and Technology Policy, urging the Board to exercise more of its national policy role than it had in the past. In June 1982, the Board resolved that the Foundation should play "a leadership role with respect to…other elements of the science and engineering enterprise, for example: evaluation of the health and achievements of the entire enterprise, and its human resource problems and needs."

Toward this end, the Board appointed a rare outside commission, co-chaired by William Coleman, Transportation Secretary in the Ford Administration, and Cecily Canaan Selby of the North Carolina School of Science and Mathematics. The commission's two-volume report, *Educating Americans for the 21st Century*, built a strong case for science education and for the federal government's role within it. Published in 1983, the Coleman-Selby report received less public acclaim than another report that year, *A Nation at Risk*, which stoked public outrage over low U.S. educational achievement. But the Coleman-Selby report was aimed at educators and policymakers and helped to spark teaching reform and the evolution of national standards. The report also signaled the revival of NSF's education program. By 1990, NSF's education budget would pass $300 million.

During the mid-1980s, the Board addressed another deficiency in U.S. education: undergraduate courses in science, mathematics, and engineering. The Foundation had done much over the years to support students with clear promise of scientific careers. But what about undergraduates who were not headed for Ph.Ds? A Board panel headed by Homer A. Neal, a physicist then at SUNY-Stony Brook, urged the Foundation to "bring its programming in the undergraduate education area into balance with its activities in the precollege and graduate areas as quickly as possible." Pedagogically, the panel recommended that improved undergraduate science, mathematics and engineering courses combine "hands on" research experience with formal instruction. In addition, the Foundation should also launch efforts "to improve public understanding of science and technology."

"The Foundation must concern itself with the overall excellence of the scientific and engineering knowledge base and human resources for the long-range needs of the Nation."

1982 NSB Resolution

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1985 Curl, Kroto, and Smalley discover a new form of carbon, the fullerene or "buckyball" (Nobel 1996)

1985

NSB Chair Schmitt
NSF Director Bloch

The Board adopted the Neal panel's report in March 1986. New undergraduate efforts helped move education at NSF into high gear. But they achieved more. Later testimonials counted NSF-funded improvements in the teaching of calculus as one of the most significant products ever to come out of NSF.

New Director Stresses Diversity

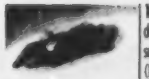
Education and workforce issues were high priorities for the two men who took the agency's top jobs in 1984. In May, physicist Roland W. Schmitt, a two-year member of the Board and senior vice president for research and development at General Electric Company, was elected Board Chair. Following the sudden departure of Director Edward Knapp, President Reagan promoted Erich Bloch from Deputy Director-designate to the Director's post. Bloch was a hard-driving IBM engineer who had managed the development and manufacture of the IBM System 360 computer technology.

All of a sudden, the Foundation had acquired a pair of leaders from industry. Bloch and Schmitt got along well and thought similarly about changes needed at NSF. Homer A. Neal, whose Board panel was devising the Foundation's undergraduate initiatives at this time, describes Bloch's results-oriented style this way: "Bloch would sit in our meetings. Sometimes he would pick up on something and carry it out before we had finished."

Part of Bloch's agenda was to help more people in underrepresented groups—minorities, women, and persons with disabilities—join America's scientific and technical workforce, including those doing advanced research. This meant increasing the numbers of these individuals who completed a K-12 mathematics/science curriculum.

Such an ambitious goal required enormous change for the Foundation, including the identification and recruitment of qualified professionals from these groups to NSF staff positions and to advisory and merit review panels. Overseeing this effort for the Board from 1984 to 1986 was Simon Ramo, co-founder of aerospace giant TRW, Inc. Ramo agreed to head the Board's Education and Human Resources (EHR) Committee because, he told Schmitt, "that's the future." Minutes of Ramo's EHR Committee meetings show that managers from all parts of NSF were systematically called on to explain exactly what steps they were taking to satisfy the new diversity mandate.

Bloch argued that diversifying the technical workforce was particularly urgent in light of limited numbers of qualified Americans to fill available jobs. The Office of Technology Assessment would later sharply criticize the data behind the "shortfall" argument, but Walter Massey, a Board member in the 1980s and the Foundation's second African American director, credits Bloch and the Board with opening the door to wider participation by underrepresented groups. The diversity campaign gained clout when programs such as EPSCoR were consolidated with programs for minorities in the renamed Education and Human Resources Directorate.



1986 Bednorz and Müller discover high-temperature superconductivity (Nobel 1987)

1986 Space Shuttle Challenger explodes

1986 Halley's comet returns

1986

NSB Chair Schmitt

NSF Director Bloch

The Debate Over Centers

Doubling the Foundation's size was among the options discussed at the Board's first long-range planning meeting with Bloch, in June 1985. Schmitt recalls, "Erich came in with the view that the Foundation had to become a central player in the Nation." Two years later, Bloch strategically chose not to attend a meeting between the Board, members of industry (including David Packard, founder of Hewlett Packard Co., and John Young, the company's chairman), and the White House at which Schmitt argued for doubling NSF's budget to $3.2 billion within five years. That active leaders of industry, and not just Bloch, wanted the Foundation to move to center stage on R&D was evidently not lost on the Reagan officials. They agreed to the plan.

But even a larger Foundation could not fund all the work that was needed. As Bloch said, "Science and engineering are just entering a long period of accelerating progress. We have never seen anything like it." A Board committee under Annelise Anderson of the Hoover Institution studied ways the Foundation could leverage federal funds so that industry, states, and other interested parties would invest in long-term basic science and engineering research—the kind of R&D that many companies found too costly and risky to conduct on their own.

An NSF initiative launched by Bloch, and encouraged by a National Academy of Engineering committee chaired by Dale Compton, made Engineering Research Centers (ERCs) the Foundation's major new initiative for leveraging NSF funds. ERCs operate as stand-alone entities on campus with long-term NSF funding matched by industry and state funds. Multidisciplinary teams conduct basic research and educate students in a real-world context, changing focus and approaches as needed to address emerging scientific issues. The first six ERC contracts were awarded in FY1985. At the same time, NSF awarded five five-year contracts for supercomputing centers modeled along similar lines. Based on these experiences Bloch also wanted NSF to sponsor a large number of Science and Technology Centers (STCs) on campuses across the country. This plan was encouraged by a National Academy of Sciences study chaired by Richard N. Zare. The first eleven STCs were selected in 1988 and funded for $25 million, ranging in focus from storm prediction to cosmology.

Some Board members questioned whether centers would take funds away from individual investigators. As a result, centers have firm time limits and cannot be renewed without recompetition.

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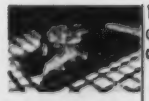
1988

1988 Bush elected President



1988 Montreal Protocol calls for international phase-out of ozone-depleting CFCs

NSB Chair Good

NSF Director Bloch

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The Ozone Hole

The Board met in March 1987 amidst global anxiety about a growing hole in the protective layer of ozone over Antarctica. A debate raged as to whether chlorofluorocarbons (CFCs), used in coolants, insulators, and sprays, were at fault. Board Chair Roland Schmitt pushed NSF to investigate the problem. The world was watching. "We were working in a goldfish bowl," says Susan Solomon of the National Oceanic and Atmospheric Administration.

Subsequently, first-time measurements taken at Palmer Station, an NSF-supported Antarctic research base, ruled out natural causes as the culprit. By the fall of 1987, international efforts were underway to limit CFC production. Solomon says that the Board's interest "helped to create the will in the logistics side of the [Foundation] to deal with the challenge and to do a more complete job."

Board member Mary Good, senior vice president of Allied Signal Corporation and eventual Board Chair in 1988, regarded the Board's status as the Foundation's legally responsible authority—and not mere advisors—as instrumental in shaping Bloch's plans for the greatest chance of success. "Erich learned a lot about how universities work from the Board," says Good, and so was better able to build his agenda around the needs of the academic community. If the Board had been only advisory, says Good, the fast-moving Bloch might not have taken this vital NSF constituency into sufficient consideration.

Controversial Projects

The Board acted as a buffer against outsiders who questioned controversial projects, thus freeing the Director to push harder at the frontiers. For example, a small group on Bloch's staff wanted NSF to take over the communications network that connected computers run by the Defense Advanced Research Projects Agency, or DARPA. Their plan was to fuse NSF's young network, known as CSNet, with the ARPANet backbone to create a larger network—NSFNet. In 1987, the Board approved the Foundation's proposal to award the administration of NSFNet to Merit Inc., an unusual consortium consisting of the University of Michigan and two private companies, MCI and IBM. The risk paid off handsomely. NSFNet grew into the Internet, an enterprise largely funded by the private sector and the cornerstone of a revolutionary new economy.

Another controversial decision marked an August 1986 Board vote to award $25 million for a new Earthquake Engineering Center at the State University of New York at Buffalo. Charles E. Hess, Vice Chair and a long-time Board member from the University of California at Davis, recalls that minutes after the award was announced, the office of Senator Pete Wilson (D-CA) telephoned to ask why the award had not gone to his home state, which had *always* done earthquake research. And who'd ever heard of earthquakes in Buffalo? Hess explained to the Senator that the Board had been just as surprised when the Foundation staff recommended Buffalo, but the Board had made its own review and concurred. Though Wilson mounted an investigation by the General Accounting Office, that office upheld the decision.

As the Foundation's stature and budget grew, more of its awards came to be coveted for their economic potential as well as opportunities for discovery. Other contentious decisions were the Board's 1990 award to build the National High Magnetic Field Laboratory at Florida State University rather than at MIT, where such work had been conducted for years, and the Board's approval in 1994 of the Laser Interferometer Gravitational Observatory (LIGO) project to detect gravity waves. Mary Good, who was Board Chair from 1988 to 1991, believes that if the Board had been merely advisory, a lone Director and staff might not have withstood the pressures. The Board, she says, "being a legally independent agency, had the power and ability to do what they thought was...right. ..and to stand their ground."

1988 Determination that DNA from a single hair can identify an individual

NSB Chair Good
NSF Director Bloch

Revisiting the Poles

In the latter part of the decade, the Board turned its attentions to another area of long-time scientific significance: the North and South polar regions. Since the International Geophysical Year programs of 1957-1958, NSF had been the lead federal agency in the Antarctic. But the budget strains of the 1970s had rendered U.S. stations and other infrastructure there in need of updating. A group of new international agreements in the 1980s further altered U.S. responsibilities in the Antarctic. In the Arctic regions, NSF was one of several agencies conducting research; then in 1984, the Arctic Research and Policy Act gave the Foundation the lead role in the Arctic as well.

For all these reasons, the Board decided to take stock of long-term needs in both polar regions. A Board Committee on the NSF Role in Polar Regions, headed by University of Maryland microbiologist Rita R. Colwell (who would become NSF Director in 1998), started work in June 1986.

Among the changes called for by the Colwell committee was a doubling of funds to update the scientific programs in basic engineering, health, medicine, and the social sciences, and to drastically improve logistics—the movement of people and supplies to and from the regions. The case for a new ice-breaking research vessel, a new South Pole station, and other improvements was bolstered by an outside panel on Antarctic safety, headed by astronaut Russell Schweickardt. Colwell's committee also urged certain infrastructure improvements, such as a new South Pole station and a new ice-breaking research vessel. Today, all fifteen of the Board committee's recommendations have been implemented, resulting in increased American influence in international polar policymaking.

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1989 NSFNet is subcontracted in plan for future spinoff of Internet to the public

1989 Communist rule in Eastern Europe crumbles; Berlin Wall falls

1989

NSB Chair Good

NSF Director Bloch

32

The 1990s

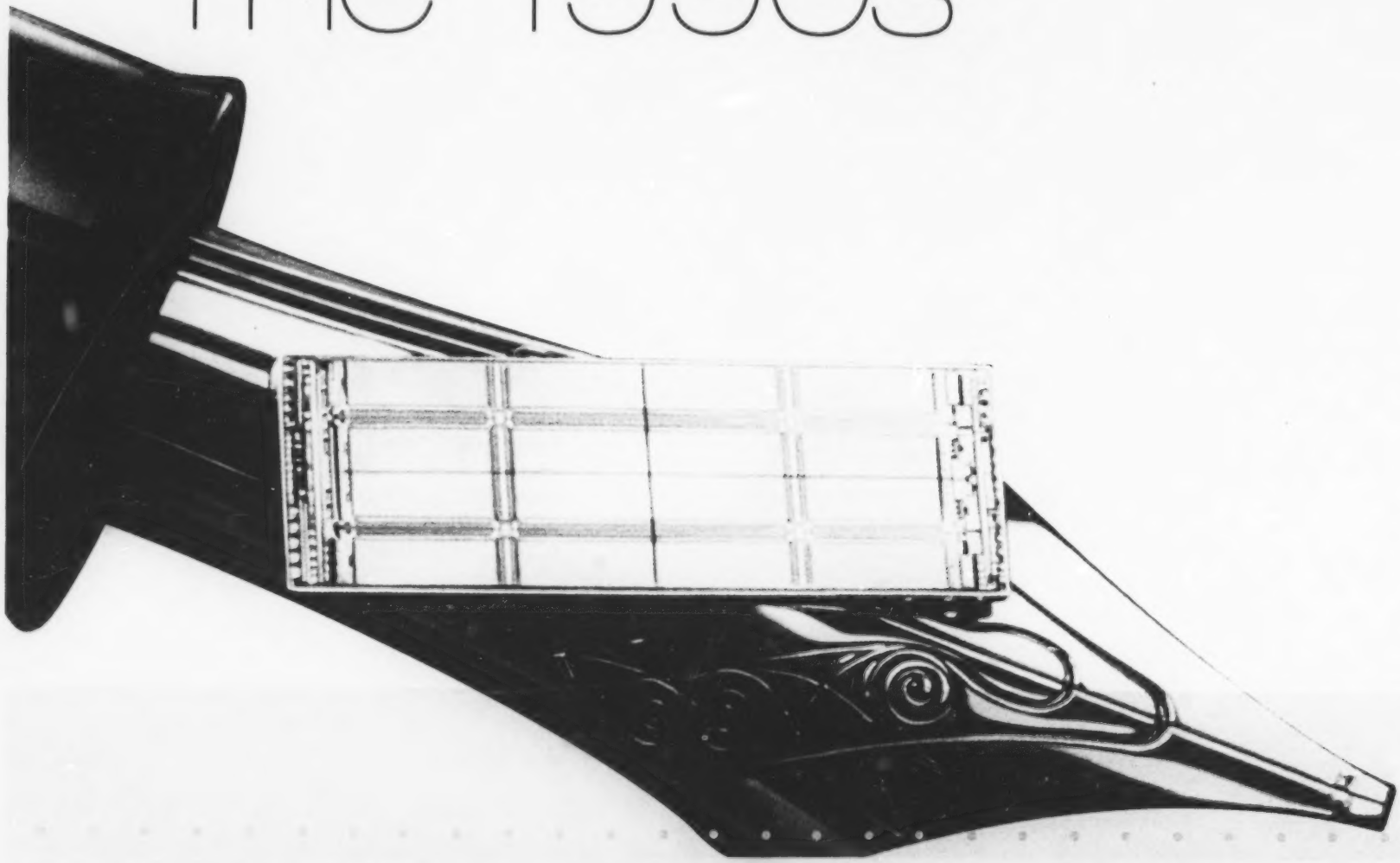


PHOTO KEY Collection

GAINING STRENGTH, SPEAKING OUT

With the collapse of the Soviet Union, the United States suddenly found itself the world's sole superpower. Yet the Nation's economy remained riddled with problems, including a huge federal deficit, an underskilled workforce, and poor K-12 education. William J. Clinton won election as President in 1992 in part because he called for government to address these issues more actively. Support for research at U.S. universities grew with the decade. Americans saw a dramatic payoff from university research after NSF opened the Internet to public and commercial use in 1991. More than in the 1980s, states helped their local institutions to compete for NSF awards. By FY2000 the Foundation's budget had topped $4 billion.

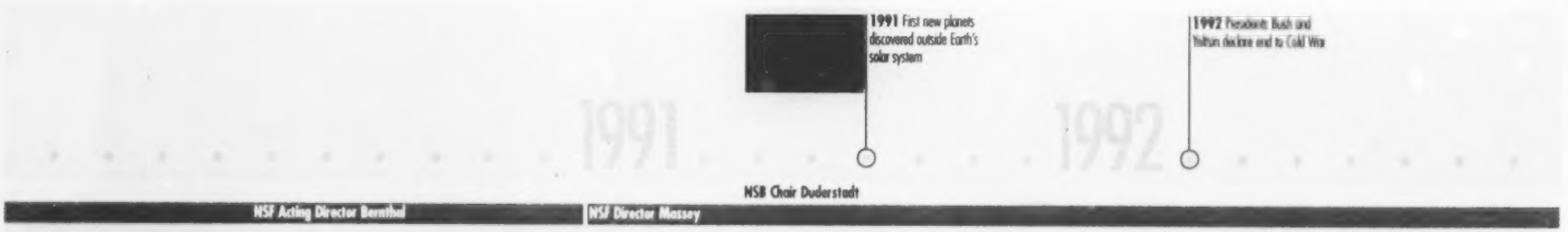
The Board offered advice within a context that was increasingly global in scope. Issues such as species loss, global climate change, and the Internet's power to distribute information highlighted the international nature of science. The Board tackled national policy issues, such as research priority-setting, now that decisions were no longer to be made under the exigencies of the Cold War. With a report that made the case for environmental research and education as a national and NSF priority, and in other statements on national policy, the Board began finally to fulfill the vision that Vannevar Bush had originally spelled out in Science—The Endless Frontier.

Systemic Change

One of Erich Bloch's last initiatives as director was also among his boldest. In 1990, following his departure, the Board approved the Foundation's program for Statewide Systemic Initiatives (SSI) in Science, Mathematics, and Engineering Education. The era of "systemic reform" began in 1991 as SSI agreements were made with selected states to bring different parts of their education apparatus into alignment with reform. A second version known as Urban Systemic Initiatives funded agreements with large-city school districts that proposed to use Foundation turnkey funds to deliver better teaching to these mostly minority student populations. Rural Systemic Initiatives, which crossed state and school district boundaries, came later.

Bloch's successor, physicist Walter E. Massey, long-time director of Argonne National Laboratory, credits the Board's Education and Human Resources Committee for close work with NSF staff on defining the new initiatives' goals. Board involvement assured that these were cooperative agreements, not grants, with ongoing obligations as well as continuing technical advice.

Though NSF's funding for these and other ambitious K-12 programs remained tiny compared to the Department of Education's portfolio, "the Board was supportive because these could be so important to the country," says James J. Duderstadt, a nuclear engineer and president of the University of Michigan who was Board Chair from 1991 to 1994. Educators widely applauded NSF for "sticking its neck out," in the words of one SSI participant. Nobody, they said, had asked them to "think systemically" before.


1991
1991 First new planets discovered outside Earth's solar system
1992
1992 Presidents Bush and Yeltsin declare end to Cold War
NSB Chair Duderstadt
NSF Acting Director Bernthal
NSF Director Massey

Meanwhile, the Foundation underwent a systemic change of its own when a new Directorate for Social, Behavioral and Economic Sciences was created in 1991. The social sciences were coming into their own, and had bearing on vital national issues. Massey recalls that the Board neither opposed nor championed a separate directorate, though some Board members did warn that social sciences on their own might be more vulnerable to political attack, as they had been in the past.

Beleaguered Industry

The end of the Cold War prompted the question of what priorities should guide U.S. industry in its multibillion-dollar expenditure on R&D. Former NSB Chair Roland Schmitt and TRW, Inc., Vice President Arden Bement, an industrialist on the Board, issued a 1992 report citing "significant gaps in U.S. industrial R&D strength" due to lagging investment and poor distribution of effort. The report said companies were spending too much on defense R&D at the expense of innovation that could invigorate the civilian sector. These ideas foreshadowed the Clinton Administration's 1993 manifesto, *Technology for America's Growth.*

At the same time, the Board was engaged in a more ambitious effort to define how NSF-funded research could better help industry and the Nation. Senator Barbara Mikulski (D-MD), who oversaw NSF's appropriations, had declared that seventy percent of Foundation funds should be allocated for "strategic" research, which alarmed those at the Foundation who took "strategic" to mean "applied." Just as worrisome to some on the Board was that organizing NSF according to strategic directions risked creating institutional rigidities incompatible with the evolutionary, fluid nature of discovery—what is an appropriate strategic goal today might not be tomorrow.

The Board appointed an outside commission co-chaired by Robert Galvin, chairman of Motorola, and William Danforth of Washington University. Duderstadt says the commission was "to interact with the broader scientific community to get a better sense of what the Foundation should be." The Danforth-Galvin report in 1993 argued that NSF-funded basic research could play a larger role in the Nation if it had clearer links to industry and other national needs.

Through a committee chaired by Cornell University president Frank Rhodes, the Board offered assistance to John S. Gibbons, President Clinton's Science Advisor, "in developing a process for scientific priority-setting," Duderstadt says. While this particular effort didn't bear fruit, it provided a foundation for later policy recommendations on the part of the Board that would be more successful.

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1992 Clinton elected President

1992 World Wide Web is released (invented at CERN 1988)

1992 Congress cancels Superconducting Supercollider

NSB Chair Duderstadt
NSF Director Massey

How to Measure Performance

Neal Lane, a computational physicist who had been provost of Rice University, succeeded Acting Director Frederick Bernthal in 1993. Popular and effective, he would remain until moving to the White House in 1998 as President Clinton's Science Advisor. While NSF management was in sure hands, the Board had plenty of oversight challenges. The Government Performance and Results Act (GPRA) of 1993 requires federal agencies to account for program results through a system of performance measurements. Progress is noted by OMB and Congress at budget time. But the open-ended nature of discovery-driven research is notoriously resistant to short-term assessment. What's more, grantmakers pressured for close accountability can become too cautious, neglecting emerging fields or risky investigations for those already likely to bear fruit.

The Foundation won approval to use more qualitative measures of performance. Its first GPRA plan was issued in 1995. A report, *NSF in a Changing World*, summarized the NSF strategic plan in which the Board was to watch closely whether Foundation awards and actions matched the new GPRA outcomes. Such outcomes included making "connections between discoveries and their use in service to society," and whether, for example, the Foundation's $700 million education programs were producing a "diverse, globally oriented science and engineering workforce."

The Frontier of Information Technology

By the late 1980's NSF assumed a strong role in computer and information science and engineering, including networking and high performance computing. One initial use of the NSFNet in the late 1980s was to link supercomputer centers, which enable ever-more refined models of galaxies, weather, proteins, and other complex phenomena. These five-year supercomputing center awards were recompeted in 1989 and 1990, sparking lively Board debate. Some members argued that individual grants would advance the field sufficiently, but the case for concentrating funds at centers won out when four of the five centers were renewed. In 1993, when the Clinton Administration made advanced computing a national priority, the NSF supercomputing centers were showcased as the Nation's best civilian facilities.

NSF decommissioned the NSFNet in April 1995 and universities began receiving Internet service from commercial providers. At the same time, NSF with MCI implemented vBNS, a new, high-capacity network for scientific computing. Meanwhile, the five-year awards for the supercomputing centers were coming to an end. In 1995, a Foundation task force cochaired by chemist Edward F. Hayes of Ohio State University,

1992 Proof put forward of 1670 theorem of Pierre de Fermat

1992 Graduate Student Marc Andreesen works on NCSA Mosaic, which will allow point and click web browsing without typing

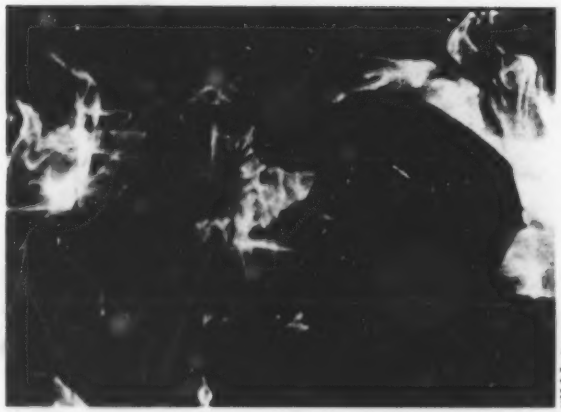
1992 Very Long Baseline Array, world's largest astronomical instrument, begins operation

NSB Chair Duderstadt

NSF Director Massey

recommended that, instead of four or five centers, partnerships among a wide range of institutions having a single super-advanced machine at their apex would best take advantage of recent massive leaps in computing capabilities.

The Board liked the idea and in 1997 approved the Foundation's proposed competition for the new Partners for Advanced Computational Infrastructure (PACI) program. Today, there are two national partnerships: the National Computational Science Alliance, led by the University of Illinois at Urbana-Champaign, and the National Partnership for Advance Computational Infrastructure at University of California, San Diego. When PACI was announced, Board Vice Chair Diana Natalicio said it will push "technological advances that will fuel future economic growth." Students and scientists "at all levels will enjoy a vast resource for education and training."



NSF Collection

A Vision for a National Role

Often in the past, the Board focused more on its NSF oversight responsibilities than on its national policy mandate. But in the 1990s, as the Board passed a mature forty years of age, ecologist and former Board member Shirley S. Malcom of the American Association for the Advancement of Science (AAAS), says the Board became more of a "*National* Science Board."

Stanford University chemist Richard N. Zare, who joined the Board in 1992 and became its chair in 1996, championed a strong vision for how the Board could exercise its legal mandate to "advise the President and Congress, whether on their request or on its own initiative" regarding policy matters related to science and engineering, and on education in these fields.

The group is "a sounding board," he says, "a forum to bring together visions for the future from different federal agencies and stakeholders." The Board should not set a particular President's science policy or respond to near-term exigencies; these duties belong to the President's Science Advisor and to the President's Committee of Advisors on Science and Technology (PCAST). But the National Science Board is uniquely positioned to "engage in long-term planning" of scientific needs and strategies. He notes that members' terms are six years, whereas the President who appoints them serves four. What's more, the Board Chair is elected by the members, not chosen by the President. "This makes [the Board] as nonpolitical a policy group as it can be," while still carrying the authority of a federal body—the only governmental body with a legal mandate to advise the President and Congress on the health of science, engineering, and related education across all fields.

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1993 Carolyn and Gene Shoemaker and David Levy discover the comet subsequently observed crashing into Jupiter

1993 1994

NSB Chair Duderstadt | NSB Chair Rhodes

NSF Acting Director Bernthal | NSF Director Lane

"Vannevar Bush's vision was that the Board would do it all," Zare notes. "But there was not a big National Institutes of Health in 1945; there was no White House Science Advisor. I'm not trying to roll back time. I'm pointing out there's a need to do something now, in addition to what the White House does."

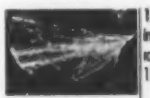
As Chair, Zare waded into the key national science policy question of the day: how the government should set federal research priorities in light of inevitable limits on spending and the growing expense and scale of basic research. Former Board members and chairmen James Duderstadt and Frank Rhodes had initiated the Board's consideration of the issue in the early 1990s. Now Zare and other Board members went a step further and met with past presidential Science Advisors and research directors from other federal agencies to discuss their basic research programs and needs, and how the Board could be useful to them. In 1997, the Board issued its report. *Government Funding of Scientific Research* argued that given the wholly new, global context for research, and the dramatic breakthroughs in so many fields at once, "one must also ask what is the appropriate scale of the investment to meet the needs of the greatest economic power in the world."

Strategic Directions for Education, Scientific Freedom, and the Environment

Having offered to work with other agencies and stakeholders while overseeing the Foundation (which was growing in accord with its 1995 NSF strategic plan), the Board spelled out its own priorities and work plan. The *National Science Board Strategic Plan* was produced in 1998 during the chairmanship of economist Eamon M. Kelly, president emeritus of Tulane University.

Eventually, the NSB plan and earlier NSF plans would serve as the basis of a new NSF strategic plan in 2000. The new NSF strategic plan was intended to guide the Foundation in meeting its goals of upholding U.S. "world leadership in all aspects of science and engineering," in "promoting discovery, integration, dissemination and employment of new knowledge in service to society," and in achieving "excellence in U.S. scientific, mathematics, engineering and technical education."

Kelly, the first social scientist to be elected as NSB chair, shared Zare's vision of an active national policy board and drew up an ambitious set of objectives. Beyond oversight for the Foundation, the Board's own strategic plan called for the Board to "provide advice to the President and Congress on major issues" (especially in federal research priorities, education, and public understanding and enrichment). The Board will also take into account the globalization of scientific issues. At the heart of the plan was the idea that the Board could best influence national policy by fostering "cooperation with other stakeholders," including other federal agencies, universities, industries, and public groups.



1995 NSFNet decommissioned; Internet fully public and growing rapidly; by 1996 it will have 12.8 million hosts

1995 Genes that switch on flowering in plants found, using *Arabidopsis* data; some 600 mutant genes of *Arabidopsis* have been discovered and mapped

1995

NSB Chair Rhodes

NSF Director Lane

"If in the twentieth century, science and technology moved to the center of the stage, in the twenty-first century they will command it. Quality of life will depend in large measure on the generation of new wealth, on safeguarding the health of our planet, and on opportunities for enlightenment and individual development. The contributions of research [will] make possible advances in all these areas."

1998 NSB Strategic Plan

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After the strategic plan was released, the Board became more active in policy matters. In 1998 the Board responded to TIMSS, the Third International Math and Science Study, which showed U.S. fourth-grade students near the top internationally but middle and high-school students faring progressively worse: U.S. twelfth-graders ranked nineteenth of twenty-one industrial nations. In a statement, "Failing Our Children," the Board declared its "special responsibility to enlist the science and engineering community as a precious resource" to support and improve "local programs."

The need for national education standards—a "common core of mathematics and science knowledge"—was pounded home the next year in *Preparing Our Children*. The report, prepared by a Board task force chaired by Mary K. Gaillard of the University of California at Berkeley, suggested that a core science and mathematics curriculum could counter the disadvantages faced by children who frequently change schools.

In 1999, when the Kansas State Board of Education decided evolution would no longer be required in courses and tests, the Board called the move "a retreat from responsibility." The Board condemned the removal from school curricula of such a key piece of scientific knowledge "at a time of already profound concern about the quality of mathematics and science education in our Nation's schools."

In September 2000, the National Commission on Mathematics and Science Teaching for the 21st Century released its report, *Before It's Too Late*, which reinforced the recommendation made by the Board in 1998. The Commission, chaired by Senator John Glenn (D-OH), stated that "the future well-being of our Nation and people depends not just on how well we educate our children generally, but on how well we educate them in mathematics and science specifically."

Also in 2000, a Board Committee on Communication and Outreach, chaired by M.R.C. Greenwood, Chancellor of the University of California at Santa Cruz, urged the science and engineering communities to establish a broad-based public information group to increase public appreciation of science and engineering and urged Board members to increase their activities as "personal ambassadors" for science, engineering, and NSF. Such efforts would further the Board's strategic goal of helping the general public understand "the joy and fascination of science as well as its utility."

The Board reaffirmed its role as a defender of open scientific communications by protesting ill-conceived and restrictive policies in connection with espionage charges against a scientist, a naturalized U.S. citizen, at Los Alamos National Laboratory: "Discouraging scientists and engineers from working in world-class facilities for reasons of national origin, ethnicity, or citizenship...could undermine our long-term security interests," the Board said, and "deny American science and engineering the benefits of openness and excellence."

1995 Physicists create a new form of matter, the long-sought Bose-Einstein condensate, allowing easier exploration of quantum mechanics

1996

NSB Chair Rhodes

NSB Chair Zare

NSF Director Lane

By 1998, private groups were lobbying for a new institute for environmental research, possibly to be housed with its own board at NSF. Many at the Foundation feared that adding a separate vertical structure would cripple the agency's ability to sponsor work across disciplines, one of its strengths. Kelly appointed a Board Task Force on the Environment under Jane Lubchenco of Oregon State University, an authority on sustainable ecology and past president of the AAAS. The goal was to define a future-oriented environmental research portfolio for the agency.

The task force took inventory of NSF's current efforts and interviewed other agencies about their environmental projects. The survey uncovered "enormous gaps," says Lubchenco, in the research, education, and scientific assessment that should be done and the technologies that should be deployed. In 2000, the Board unanimously approved a new vision for NSF contained in its report, *Environmental Science and Engineering for the 21st Century: The Role of the National Science Foundation*. The report recommends that Foundation support for environmental research should grow by $1 billion over the next five years—a hefty jump from the $600 million the agency was currently spending. The report also recommends that NSF create new mechanisms for enabling environmental activities.

PCAST warmly welcomed the report and endorsed the plan for NSF to become a leader of federally funded basic research in the environmental sciences. Rita R. Colwell, who became the first woman to head the Foundation in August 1998, has since established a major initiative in the area of Biocomplexity in the Environment.

2000 and Beyond

The Board's agenda and the Foundation's under the leadership of NSF Director Rita Colwell meshed with that of the Clinton White House. For FY2001, the President requested, and Congress approved, the largest budget increase in Foundation history—13.6 percent. In addition to support of core areas, other priorities included information technology research, where NSF already had a primary role. Another is nanoscale science and engineering. NSF leads other federal agencies in efforts to understand phenomena on the scale of one billionth of a meter. A third area of emphasis is biocomplexity, kicking off the Foundation's growth in the environmental realm.

Another critical objective is building the twenty-first century workforce. NSF is continuing to develop human resources at all levels of education—formal and informal, in schools, homes and communities. The Foundation will give priority to research on learning, systemic reform, teacher preparation, rigorous instruction, and accountability. "From here on," Kelly says, "it will be a question of public understanding and political will" to improve U.S. student achievement.

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1998 NSF begins work on a new U.S. research station at the South Pole

1998 Neal Lane becomes President's Science Advisor

1998

NSB Chair Kelly

NSF Director Colwell

"We are inspired by all that our predecessors have accomplished. I hope that in another fifty years, those who follow us will find similar reasons to celebrate."

Eamon M. Kelly, Board Chair, (1998-2002)

While the Foundation's budget is likely to grow, basic research—which is now primarily funded by the federal government—is just 0.002 percent of the total U.S. economy. This alarms Kelly. "We know as a result of the past fifty years that basic research is the only investment that pays off with such high returns," he says. "Applied research and development work do not have anywhere near the same impact."

In coming years, Kelly says the Board will push hard to "stimulate the political environment and the public's understanding" to realize the importance of a higher level of investment in basic research. The Foundation, he says, "is responsible for the health of the scientific enterprise, and the only agency responsible for the general well-being of the entire spectrum of the natural and social sciences."

In this sense, the National Science Foundation is a national treasure. For 50 years, it has enabled scientists and engineers to advance an endless frontier. What would Vannevar Bush think if he could see the National Science Board today? Kelly's ready answer is: "He would see the fulfillment of a vision in which the Board has moved science policy to center stage in the service of the Nation."

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2000

NSB Chair Kelly

NSF Director Colwell

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April 1951–October 1953

E. Vernice Anderson
October 1953 –September 1981

Margaret Windus
September 1981–August 1985

Thomas Ubois
August 1985–May 1992

Marta Cehelsky
May 1992–present

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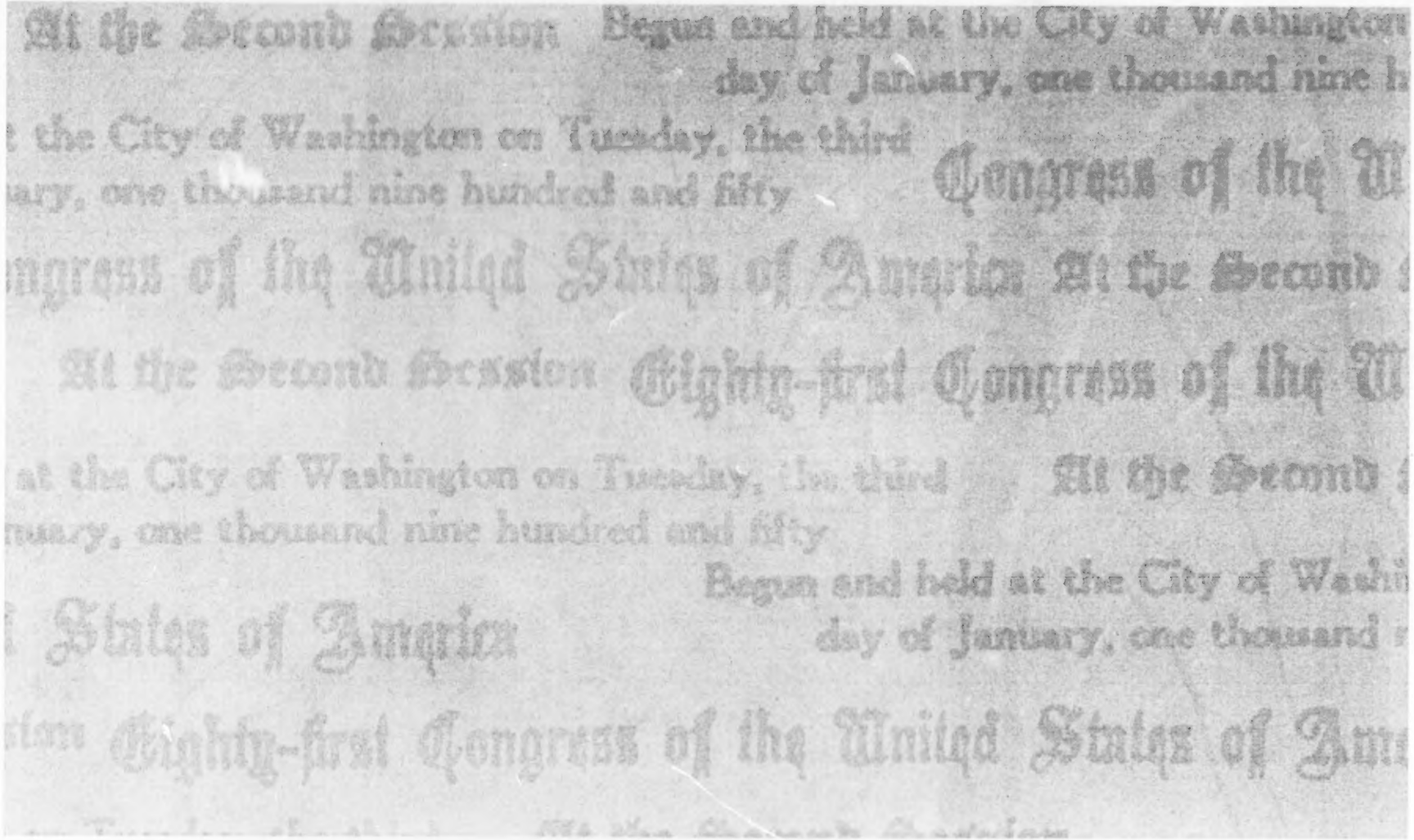
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